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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/846,980	04/30/2001	Stephen A. Stockman	M-9635 US	3906

24251 7590 10/22/2002

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	7

DATE MAILED: 10/22/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/846,980	STOCKMAN ET AL.
	Examiner	Art Unit
	Matthew J Song	1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 and 2-60* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1 and 2-60* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 1 and 3-30 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. While the limitation of preventing additional hydrogen from diffusing into the said acceptor doped layer substantially during the cool down process is supported, there is no support for "during the entire cool down process".

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 33 and 34 recites the limitation "said preventing additional hydrogen from diffusing" in line 1-2. There is insufficient antecedent basis for this limitation in the claim, likewise for claim 34.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims 1, 3-5, 12-30, 31-35 and 42-60 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bour et al. (US 5,926,726) in view of Koike et al. (US 5,811,319).

Bour et al. teaches a carrier gas of H_2 is introduced with reaction gases NH_3 and TMGa and impurity gas Cp_2Mg to a reactor to form a p-type GaN layer at a temperature of 900°C (col 6, 20-26) After formation of the p-type nitride layer the reactant gases are switched out of the reactor and a gas which prevents the decomposition of the III-V layer at such high growth temperatures, NH_3 is added (col 5, ln 60-65 and col 6, ln 31-35). Bour et al also teaches a reactor is cooled down to a temperature where surface decomposition of as-grown p-type GaN layer will not further occur, where upon attainment of the this temperature, the preventer gas, NH_3, is switched out of the reactor and the remaining cool down occurs in molecular N and acceptor activation is preformed either as the reactor is further cooled or maintained at a temperature of 600°C for 20-40 minutes and during the cool down of the reactor a flow of molecular N, N_2, is maintained in the reactor. (col 6, ln 40-65). Bour et al also teaches the anneal process is a quasi-in-situ anneal, where the reactor is brought to room temperature prior to annealing (col 2, ln 32-45) and that ex-situ post-growth anneals have become a common procedure for laser diode processing (col 2, ln 60-64). Bour et al also teaches acceptor activation is the process of atomic H weakly bonded to Mg or Zn dopant atoms are broken by thermal annealing over a period of time (col 6, 7-15) Bour et al also teaches a device which comprises a sapphire substrate upon which is grown a n-type GaN, doped with Si followed by the growth of an active region and is

followed by a p-type GaN layer doped with Mg followed by the growth of a cap layer comprising n-type GaN doped with Si (col 8, ln 46-55) Bour et al also teaches that after growth is complete and the reactor cooldown has been accomplished, the n-type cap layer may be removed by etching and the device processed into an operable laser, this reads on applicant's limitation of forming a light emitting diode. Bour et al also discloses the switchout of the NH_3 gas is possible at temperatures as high as the lower end of the growth temperature range for GaN that is around 900°C and maybe higher, with an ambient of N_2 provided in the reactor, activation may be accomplished in a short period of time (col 7, ln 15-40). Bour et al also teaches after the growth of p-type GaN, all reaction gases are switched out of the reactor including NH_3 and immediately after growth dimethylhydrazine is pumped into the reactor and the activation process can be carried out during the cooldown of the reactor, this reads on applicant's substantially preventing hydrogen passivation during the entire cooldown process (col 7, ln 55-67 and col 8, ln 1-30).

Bour et al does not teach the causing of the acceptor doped layer to a p-type layer have a conductivity and a hole density between 3×10^{15} cm^{-3} and 1×10^{18} cm^{-3} after said cool down process.

In a method of growing p-type gallium nitride, Koike et al. teaches three p-layers of Mg-doped $Al_{x1}Ga_{1-x1}N$ forms a p-layer (61) which acts as a clad layer having a hole concentrations of $5 \times 10^{17}/cm^3$, $5 \times 10^{17}/cm^3$ and $2 \times 10^{17}/cm^3$ and an Mg concentrations of $1 \times 10^{20}/cm^3$, $1 \times 10^{20}/cm^3$ and $2 \times 10^{20}/cm^3$, respectively (col 3, 50-65). Koike also teaches electron rays were uniformly irradiated into the p-layer using a reflective electron beam, where this irradiation changed the p-layer into a p-type conductive semiconductor with a hole concentration of 5 x

$10^{17}/cm^3$, 5 x $10^{17}/cm^3$ and 2 x $10^{17}/cm^3$ and a resistivity of 0.5 ohm-cm, 0.8 ohm-cm and 1.5 ohm-cm, respectively (col 5, ln 14-26). Koike et al also teaches forming metal electrode, such as nickel or aluminum, are formed on semiconductor devices utilizing GaN group compounds such as AlGaInN after the semiconductor surface is cleaned by wet chemical etching, utilizing a wet chemical etchant such as buffered hydrogen fluoride (col 1, ln 15-30).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Bour with Koike's electron beam irradiation because it would have produced p-type conductive semiconductors with low resistivities.

Referring to claim 1 and 31, the combination of Bour et al and Koike et al teaches the switchout of NH_3 is possible at temperatures as high as the lower end of the growth temperature range for GaN and maybe higher with an ambient of N_2, this reads on applicant's limitation of preventing additional hydrogen from diffusing into the acceptor doped layer substantially throughout the entire cool down process.

Referring to claim 3 and 33, the combination of Bour et al and Koike et al teaches a step (32) where reactant gases are switched out of the reactor and a flow of N_2 is maintained during the cooldown of the reactor. This reads on applicant's limitation of preventing additional hydrogen from diffusing into said acceptor-doped layer during said cooling process. Also this reads on applicant's limitation of removing hydrogen from said chamber during cool-down process and preventing hydrogen from entering.

Referring to claim 4 and 34, the combination of Bour and Koike teach a cap layer comprising n-type GaN doped with Si, this reads on applicant's limitation of preventing

additional hydrogen from diffusing into said acceptor-layer comprising form a n-type semiconductor layer over said acceptor-doped layer prior to said cool-down process.

Referring to claim 5 and 35, the combination of Bour and Koike teach electron beam irradiation of said p-type layer to produce conductive semiconductors with low resistivities with hole densities of greater than 1 x $10^{17}/cm^3$. This reads on applicant's limitation of treating a surface of said acceptor-doped layer to increase hole density to be greater than 3 x 10^{15} cm^{-3}.

Referring to claim 13 and 43, the combination of Bour et al and Koike et al teaches electron rays were uniformly irradiated into the p-layer using a reflective electron beam, this reads on applicant's limitation of exposing said surface to electromagnetic radiation.

Referring to claim 14 and 44, the combination of Bour and Koike does not teach growing an acceptor doped layer results in acceptor impurities in said acceptor-doped layer having greater than 90% passivation prior to said cool down process. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Bour and Koike by attempting to optimize same by routine experimentation.

Referring to claim 15-16 and 45-46, the combination of Bour and Koike teach three p-layers of Mg-doped $Al_{x1}Ga_{1-x1}N$ p-layer (61) which acts as a clad layer having a hole concentrations of 5 x $10^{17}/cm^3$, 5 x $10^{17}/cm^3$ and 2 x $10^{17}/cm^3$ and an Mg concentrations of 1 x $10^{20}/cm^3$, 1 x $10^{20}/cm^3$ and 2 x $10^{20}/cm^3$. This reads on applicant's limitation of a hole density greater than 3 x 10^{16} cm^{-3} and having a density of acceptor impurities greater than 5 x 10^{18} cm^{-3}.

Referring to claim 18 and 48, the combination of Bour and Koike does not teach the annealing is carried out at a temperature below 400°C. It would have been obvious to a person of

ordinary skill in the art at the time of the invention to modify the combination of Bour and Koike by attempting to optimize same by routine experimentation.

Referring to claim 19 and 49, the combination of Bour and Koike teach all of the limitations of claim 19, except an ex-situ anneal. The combination of Bour and Koike teach ex-situ post-growth anneals have become a common procedure for laser diode processing. It would have been obvious to a person of ordinary skill in the art at the time of the invention to perform the annealing process ex-situ because it allow the reaction chamber to be used to for the growth of more p-type GaN.

Referring to claim 20 and 50, the combination of Bour and Koike teach the anneal process is a quasi-in-situ anneal where the reactor is brought to room temperature prior to annealing, this reads on applicant's limitation of annealing is carried out after said cool-down process prior to any further processing of said p-type layer.

Referring to claim 21 and 51, the combination of Bour and Koike teach a device (40) processed into an operable laser, this reads on applicant's limitation of forming a light emitting diode.

Referring to claim 22 and 52, the combination of Bour and Koike teach a sapphire substrate upon which is grown a n-type GaN, doped with Si followed by the growth of an active region and is followed by a p-type GaN layer doped with Mg.

Referring to claim 23 and 53, the combination of Bour et al and Koike et al. teaches three p-layers of Mg-doped $Al_{x1}Ga_{1-x1}N$ forms a p-layer (61).

Referring to claim 25 and 55, the combination of Bour et al and Koike et al. does not teach annealing is carried out to remove said hydrogen from said p-type layer as well as anneal or alloy a p-type ohmic contact.

7. Claims 6, 9, 11, 36, 39 and 41 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bour et al. (US 5,926,726) in view of Koike et al. (US 5,811,319) as applied to claim 1 above, and further in view of Takatani (US 6,100,174).

The combination of Bour et al and Koike et al teach all of the limitations of claim 6, except chemically etching said surface.

In a method of producing GaN group compound semiconductors, Takatani teaches a p-GaN layer epitaxially grown on a sapphire substrate, with about 10^{19} cm^{-3} of Mg added thereto for providing a carrier density of about 1.5×10^{17} cm^{-3}, where carrier density reads on applicant's term of hole density. Takatani also teaches subjecting the surface of the p-GaN layer to ultrasonic cleaning in acetone and ethanol, thereby removing the oil present thereon and then immersing in an etchant containing HCl and deionized water for about 3 minutes, thereby removing the adsorbed oxide and then the substrate is immersed in an etchant containing HF and deionized water for about 3 minutes thereby removing impurities adhering to the surface, this reads on applicant's limitation of chemically etching. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the invention taught by the combination of Bour and Koike with Takatani's etching because it would have removed impurities and adsorbed oxygen from the substrate.

Referring to claim 9 and 39, the combination of Bour et al and Koike et al teach all of the limitations of claim 9, except chemically cleaning said surface.

Takantani teaches immersing a p-GaN substrate in an etchant containing HCl and deionized water for about 3 minutes, thereby removing the adsorbed oxide and then the substrate is immersed in an etchant containing HF and deionized water for about 3 minutes thereby removing impurities adhereing to the surface. This reads on applicant's limitation of chemically cleaning said surface.

Referring to claim 11 and 41, the combination of Bour et al and Koike et al teaches all of the limitations of claim 11, except ultrasonically cleaning said surface. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the invention taught by the combination of Bour et al and Koike et al with Takatani's ultrasonic cleaning because it would have removed the oil present on the surface of the substrate, which is detrimental to the surface.

8. Claim 10 and 50 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bour et al. (US 5,926,726) in view of Koike et al. (US 5,811,319) and Takatani (US 6,100,174) as applied to claim 9 above, and further in view of Peng et al. (US 5,895,223).

The combination of Bour et al, Koike et al and Takatani teach all of the limitations of claim 10, expect the cleaning of said surface comprises cleaning in a solution of KOH, NaOH or NH_4OH.

In a method of etching nitride, Peng et al teaches dipping a nitride chip in an electrolysis liquid and emitting a UV light with a wavelength of 254 nm to illuminate the nitride chip (col 3,

ln 40-46), where the electrolysis liquid can be one of KOH as the nitride chip is GaN. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Bour et al, Koike et al and Takatani with Peng's because the etching method of Peng offers a finer roughness for an etching surface (col 4, ln 20-24).

9. Claim 13 and 43 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bour et al. (US 5,926,726) in view of Koike et al. (US 5,811,319) as applied to claim 5 above, and further in view of Peng et al. (US 5,895,223).

The combination of Bour et al and Koike et al teach all of the limitations of claim 13, expect exposing said surface to electromagnetic radiation.

In a method of etching nitride, Peng et al teaches dipping a nitride chip in an electrolysis liquid and emitting a UV light with a wavelength of 254 nm to illuminate the nitride chip (col 3, ln 40-46), this reads on applicant's limitation of exposing to electromagnetic radiation, where the electrolysis liquid can be one of KOH as the nitride chip is GaN. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Bour et al, Koike et al and Takatani with Peng's because the UV light would illuminate the nitride chip.

10. Claim 7-8 and 37-38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bour et al. (US 5,926,726) in view of Koike et al. (US 5,811,319) as applied to claim 5 above, and further in view of Nitta et al (US 5,789,265).

The combination of Bour et al and Koike et al teach all of the limitations of claim 7, expect plasma etching said surface.

In a method of manufacturing a blue light emitting diode, Nitta et al. teaches a dry etching method for GaN based semiconductor compounds can be achieved by the plasma etching using BCl_3 and Cl_2, where said GaN based semiconductor comprises p-type $In_xGa_{1-x}N$ (col 4, ln 41-55). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Bour et al and Koike et al with Nitta et al because etching rate can be increased and productivity enhanced.

Referring to claim 8, Nitta et al. teaches a dry etching method for GaN based semiconductor compounds, this reads on applicant's limitation of plasma cleaning said surface.

Response to Arguments

11. Applicant's arguments filed July 25, 2002 have been fully considered but they are not persuasive.

In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). The combination put forward above derives motivation in that Bour et al teaches a

method of activation of Group III-V nitride compound semiconductors and Koike et al teaches a method of lowering resistivities of semiconductors by irradiating with an electron beam. Thus, one of ordinary skill would have been encouraged to perform such a process of lowering the resistivity of the semiconductor using these known methods because lower resistivity enhances performance of the semiconductors, as previously stated on page 5 of the rejection, paper 3.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Koike et al is not relied upon to teach the management of hydrogen in the reaction chamber, Bour et al teaches the management of hydrogen in the reaction chamber. The combination of Bour et al and Kioke et al teaches all the limitations of claim 1.

The argument against Bour et al is not convincing. Bour et al teaches the switchout of NH_3 is possible at temperatures as high as the lower end of the growth temperature range for GaN and maybe higher with an ambient of N_2, this reads on applicant's limitation of preventing additional hydrogen from diffusing into the acceptor doped layer substantially throughout the entire cool down process (col 7, ln 15-40). Bour et al also teaches the time at which NH_3 is switched out of the reactor is critical, after nitride layer growth **or** during cooldown itself. Bour et al teaches that switchout of NH_3 occurs after nitride layer growth at a lower end of the growth temperature range, which reads on applicant's substantially preventing additional hydrogen from diffusing into the acceptor doped layer during the entire cooling process. Additionally, Bour et al also teaches after the growth of p-type GaN, all reaction gases are switched out of the reactor

including NH_3 and immediately after growth dimethylhydrazine is pumped into the reactor and the activation process can be carried out during the cooldown of the reactor, this reads on applicant's substantially preventing hydrogen passivation during the entire cooldown process (col 7, ln 55-67 and col 8, ln 1-30).

In response to applicant's argument concerning claim 13, that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., photons) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). The combination of Bour et al and Koike et al teaches an electron beam, which is a form of electromagnetic radiation.

Applicant's arguments filed 8/9/2002 have been fully considered but they are not persuasive

In response to applicant's arguments in regards to claim 31, "annealing said p-type layer at a temperature below 625°C to remove hydrogen" is found at column 2, lines 32-45 is incorrect. The examiner cites column 6, lines 40-65 as a teaching of applicant's annealing below 625°C to remove hydrogen. Bour et al teaches annealing at 600°C for 20-40 minutes (col 6, ln 40-65). Bour et al's teaching in column 2, lines 32-45 is used as a general teaching of in-situ annealing. Also Nakamura is not relied upon for the basis of the rejection. Also in regards to Bour et al teaching away from annealing is inaccurate because Bour et al discloses a method of acceptor activation via low temperature annealing (col 6, ln 50-60) and separate method where acceptor activation is achieved through the use of a n-type capping layer (col 8, ln 45-67), where

with the n-type capping layer annealing is not necessary for acceptor activation. It is also noted that Bour et al teaches the annealing is not **necessary** for acceptor activation, where this is not a teaching away from annealing because it would have been obvious to a person of ordinary skill in the art at the time of the invention to anneal to activate the layer if the desired activation was not achieved after cooldown.

Conclusion

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
October 18, 2002

BENJAMIN L. UTECH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700